Air Force Research Laboratory|AFRL

Science and Technology for Tomorrow's Aerospace Forces

Materials and Manufacturing Directorate

2977 P Street • Wright-Patterson Air Force Base, Ohio • 45433-7746

Material Behavior During Processing

The ability to predict and control material behavior during processing is critical to the safe, timely, and cost-effective implementation of advanced metallic aerospace materials and manufacturing processes. The relationships between processing conditions and mechanical properties, product quality, and process yield must be understood to effect improvements in aerospace alloys. These relationships are governed by the underlying physical phenomena which are active during processing (e.g., diffusion, heat flow, fluid flow). Hence, a sustained effort in the area of processing science is essential to the continued advancement of Air Force systems.

Over the course of the last decade, the work of ML personnel has substantially advanced the understanding of the behavior of aluminum, titanium, nickel, and intermetallic alloys during thermomechanical, solidification, and vapor processing. Extensive research has been conducted in the areas of conventional and novel processing and the development of advanced material-behavior models. The result has been the successful development and implementation of various new forging, extrusion, and rapid heat-treatment processes and the optimization of existing processes.

Current processing research is focused on modeling of microstructure and texture evolution and defect formation using novel simulation methods such as cellular-automata, Monte-Carlo, phase-field, and crystal-plasticity finite-element techniques. An accurate understanding of the complex interaction between the evolution of crystallographic texture and microstructure is vital to the utility of these models. Consequently, much effort is being directed toward developing specialized techniques to collect and interpret the essential physical data for use in the simulations. Additionally, great care continues to be taken to validate the models under real-world processing conditions.